REPLACED BY ART 34 AMDT

What is claimed is:

1. A method for performing frequency hopping Orthogonal Frequency Division Multiple Accesses (OFDMA), comprising the steps of:

a) allocating frequency domain signals X(k) of a comb pattern to a modulated data sequence, X(k) being comb symbols and k being a frequency index;

b) performing frequency hopping so that the comb symbols could have an independent frequency offset; and

c) performing inverse Fast Fourier Transform (FFT) on the comb symbols to be transformed to time domain signals x(n) and transmitting the time domain signals x(n), n being a time index,

wherein the comb symbols formed of a predetermined number of sub-carriers, which is called a sub-carrier group, are positioned on an entire usable frequency band at predetermined intervals and the number of sub-carriers on the entire usable frequency is expressed as:

$$N=\sum_{i}^{N_C} N_{si}=N_C * N_S\,, \quad (N_{si}=N_s=Const.)$$

where N_C denotes the number of comb symbols that can be allocated in the entire usable frequency band;

N_{si} denotes the number of sub-carriers within an i^{th} comb symbol, the size of the i^{th} comb symbol, or the size of a sub-carrier group constituting the i^{th} comb symbol, and

$$X_{N_C,i,q}(k)=\begin{cases}\neq 0, k=p_i N_C+q_i\\ =0,\ Otherwise\end{cases}$$

$$\begin{cases}p_i=0,1,\dots,N_{si}-1\\ q_i=0,1,\dots,N_C-1\end{cases}.$$

2. The method as recited in claim 1, wherein if there are N sub-carriers and N is a power of 2 ($N=2^n$), n being an integer that is not negative, the step a) includes the steps of:

a1) forming a comb symbol tree T_{2^n} which is formed of 1 to 2^n sub-carriers, wherein a comb symbol $X_{1,0}$ having 2^n sub-carriers is a parent node and a comb symbol $X_{2^a,b}$ having 2^{n-a} sub-carriers and having a frequency offset b includes $X_{2^{a-1},b}$ and $X_{2^{a-1},b+2^a}$ as child nodes, each having 2^{n-a-1} sub-carriers and having a frequency offset b and $b+2^a$, respectively, and a comb symbol having one sub-carrier is an end node; and

a2) allocating comb symbols having appropriate size for a transmission rate requested by mobile station to the mobile station and preventing collision between the comb symbols by not allocating comb symbols corresponding to child nodes of the comb symbols in the tree T_{2^n} to the other mobile stations in the cell to which the mobile station belongs, until the comb symbols having appropriate size are released from the allocation.

3. The method as recited in claim 2, wherein if the number of sub-carriers that can carry data is not a power of 2 due to the presence of null carriers among N sub-carriers in the entire usable frequency band, N being a power of 2 ($N=2^n$, n being an integer that is not negative), part of the data corresponding to the null carriers is punctured in the step a).

4. The method as recited in claim 2, wherein if the number of sub-carriers that can carry data is not a power of 2 due to the presence of null carriers among N sub-carriers in the entire usable frequency band, N being a power of 2 ($N=2^n$, n being an integer that is not negative), any loss in the data transmission rate is prevented by inserting null data into the data at positions corresponding to the null carriers and allocating sub-carriers that are not null carriers to the data corresponding to the null carriers in the step a).

5. The method as recited in claim 1, wherein if

there are N sub-carriers in the entire usable frequency band (2^{n-1} < N < 2^{n}), the step a) includes the steps of:

a3) forming a comb symbol sub-tree T_{2^i} which is formed of 1 to $2^{n'}$ sub-carriers, wherein a comb symbol $X_{1,0}$ having $2^{n'}$ sub-carriers is a parent node and a comb symbol $X_{2^a,b}$ having $2^{n'-a}$ sub-carriers and having a frequency offset b includes $X_{2^{a-1},b}$ and $X_{2^{a-1},b+2^a}$ as child nodes, each having $2^{n'-a-1}$ sub-carriers and having a frequency offset b and b+2^a, respectively, and a comb symbol having one sub-carrier is an end node;

a4) forming a multiple-tree having a_i comb symbol sub-trees and a total of N sub-carriers by performing the step a3) with respect to each i; and

a5) selecting comb symbols having appropriate size for a transmission rate requested by a mobile station from one sub-tree out of the multiple-tree and allocating the comb symbols to the mobile station, and preventing collision between the comb symbols by not collecting comb symbols corresponding to child nodes of the comb symbols in the selected sub-tree to the other mobile stations in the cell to which the mobile station belongs, until the comb symbols having appropriate size are released from the allocation,

wherein comb symbols of the multiple-tree formed of a plurality of sub-trees are re-defined as:

$$X_{st,N_c,q}(k)\begin{cases}\neq 0, k = pN_c+q+K_{st}\\ = 0, otherwise\end{cases}$$

where st denotes a sub-tree index;

K_{st} denotes a beginning frequency index of a sub-tree; $p=0,1,\cdots,(N_{st}/N_c)-1$, N_{st} being the number of sub-carriers of a sub-tree; and

$q=0,1,\cdots,N_c-1$.

6. The method as recited in claim 5, wherein, in the step a5), the comb symbols having appropriate size for a transmission rate requested by the mobile terminal are

selected preferentially from a sub-tree having no comb symbol allocated among the sub-trees of the multiple-tree.

7. The method as recited in claim 1, wherein the step a) includes the steps of:

a6) dividing N sub-carriers existing in the entire usable frequency band into M sub-bands;

a7) forming a comb symbol sub-tree T_{2^i} which is formed of 1 to $2^{n'}$ sub-carriers, wherein a comb symbol $X_{1,0}$ having $2^{n'}$ sub-carriers is a root node and a comb symbol $X_{2^a,b}$ having $2^{n'-a}$ sub-carriers and having a frequency offset b includes $X_{2^{a-1},b}$ and $X_{2^{a-1},b+2^a}$ as child nodes, each having $2^{n'-a-1}$ sub-carriers and having a frequency offset b and b+2^a, respectively, and a comb symbol having one sub-carrier is an end node;

a8) forming a multiple-tree having M comb symbol sub-trees and a total of N sub-carriers by performing the step a7) with respect to each sub-band; and

a9) selecting the comb symbols having appropriate size for a transmission rate requested by a mobile station from one sub-tree out of the multiple-tree and allocating the comb symbols to the mobile station, and preventing collision between the comb symbols by not allocating comb symbols corresponding to child nodes of the comb symbols having appropriate size in the selected sub-tree to the other mobile stations in the cell to which the mobile station belongs, until the comb symbols having appropriate size are released from the allocation,

wherein comb symbols of the multiple-tree formed of M sub-trees are re-defined as:

$$X_{st,N_c,q}(k)\begin{cases}\neq 0, k = pN_c+q+K_{st}\\ = 0, otherwise\end{cases}$$

where st denotes a sub-tree index;

K_{st} denotes a beginning frequency index of a sub-tree;

$p=0,1,\cdots,(N_{st}/N_c)-1$, N_{st} being the number of sub-carriers of a sub-tree; and

$q=0, 1, \cdots, N_c-1$.

8. The method as recited in claim 7, wherein, in the step b), frequency hopping is performed on the comb symbols on a basis of a sub-tree to which the comb symbols allocated to the mobile station belong.

9. The method as recited in claim 1, wherein, in the step b), frequency hopping is performed on comb symbols $X_{a,b}(k)$ allocated to the mobile station in the cell according to a frequency indicator function $Y_{a,b}(k;l)$, which is a frequency hopping pattern and expressed as:

$$Y_{a,b}(k;l) == X_{a,b}((k+P(l)) \bmod N)$$

where $P(l)(0 \le P(l) \le N)$ is a frequency hopping pattern of comb symbols within a cell in a time slot l; and

N denotes the entire number of sub-carriers.

10. The method as recited in claim 1, wherein, in the step b), the comb symbols perform frequency hopping to comb symbols having the same size but different frequency offset.

11. The method as recited in claim 1, wherein, in the step b), the comb symbols perform frequency hopping so that all comb symbols have a frequency hopping pattern randomly.

12. The method as recited in claim 1, wherein, in the step b), the comb symbols perform frequency hopping so that the same frequency hopping pattern is provided to all mobile stations within the same cell.

13. The method as recited in claim 12, wherein, in the step b), the comb symbols perform frequency hopping so that mobile stations between different cells can have

different frequency hopping patterns.

14. The method as recited in claim 12, wherein, in the step b), the comb symbols perform frequency hopping so as to have different frequency hopping intervals between cells.

15. The method as recited in claim 12, wherein, in the step b), the comb symbols perform frequency hopping so that the direction of the frequency hopping could be different according to each cell.

16. The method as recited in claim 1, wherein if a comb symbol is to be allocated additionally upon a request of a mobile station, a comb symbol formed of a sub-carrier group that is adjacent to the sub-carrier group of the currently allocated comb symbol is allocated additionally.

17. The method as recited in claim 16, wherein if the additional comb symbol is formed of a sub-carrier group selected from sub-carrier groups each having the same size as the sub-carrier group constituting the currently allocated comb symbol.

18. The method as recited in claim 16, wherein, in the step b), the additionally allocated comb symbol performs frequency hopping among the sub-carrier groups each having the same size as the sub-carrier group constituting the currently allocated comb symbol.

19. The method as recited in claim 16, wherein, by utilizing a summation of sub-carrier groups constituting the allocated comb symbols as a minimum unit for frequency hopping, in the step b), the frequency hopping is performed into a comb symbol formed of a sub-carrier group that corresponds to a number obtained from:

$$G = (g_n + P(l) \times i) \bmod N_c$$

where G denotes a group number in a time slot l; $P(l)$ denotes a frequency hopping pattern function; i denotes the number of allocated groups; and g_n denotes a group number in the initial time slot, and

wherein, when a comb symbol is allocated additionally, the summation of the sub-carrier groups is the same as the summation of all the sub-carrier groups constituting the initially allocated comb symbol and the additionally allocated comb symbol.

20. The method as recited in claim 16, wherein, in the step b), the sub-carrier group constituting the initially allocated comb symbol is used as a minimum unit for frequency hopping and an allocated comb symbol performs frequency hopping.

21. The method as recited in claim 1, wherein inverse Fast Fourier Transform is performed based on Decimation In Frequency (DIF) algorithm in the step c), and the step c) includes a step of:

c1) inputting the frequency domain signals X(k) by mapping input addresses of a fast Fourier Transform (FFT) unit to the frequency indexes k sequentially.

22. The method as recited in claim 21, wherein the step c) further includes a step of:

c2) not performing butterfly computation, if 0 is inputted to all the input ends of a butterfly that forms the IFFT unit.

23. The method as recited in claim 1, wherein IFFT is performed based on Decimation In Time (DIT) algorithm and the step c) includes a step of:

c3) inputting the frequency domain signals X(k) by

mapping bit-reversed values of the input addresses of the IFFT unit to the frequency indexes k.

24. The method as recited in claim 23, wherein the step c) further includes a step of:

c4) not performing butterfly computation, if 0 is inputted to all the input ends of a butterfly that forms the IFFT unit.

25. The method as recited in claim 1, further including the steps of:

d) receiving time domain signals y(n) that corresponds to the comb symbols transmitted in the step c);

e) restoring the time domain signals y(n) into a frequency offset established initially; and

f) demodulating the modulated data sequence by performing FFT on the time domain signals y(n) to be transformed into frequency domain signals Y(k), k being a frequency index.

26. The method as recited in claim 25, wherein FFT is performed based on the DIF algorithm in the step f), and the step f) includes a step of:

f1) outputting the frequency domain signals Y(k) by mapping bit-reversed values of output address of the FFT unit to the frequency indexes k.

27. The method as recited in claim 26, wherein the step f) further includes a step of:

f2) controlling the butterfly, a part of the FFT unit, to perform or not perform computation according to the frequency domain signals Y(k) outputted from the FFT unit.

28. The method as recited in claim 25, wherein FFT is performed based on DIT algorithm in the step f), and the step f) includes a step of:

f3) outputting the frequency domain signals Y(k) by

mapping output addresses of the FFT unit and the frequency indexes k sequentially.

29. The method as recited in claim 28, wherein the step f) includes a step of:

f4) controlling the butterfly, a part of the FFT unit, to perform or not perform computation according to the frequency domain signals Y(k) outputted from the FFT unit.

30. The method as recited in claim 1, wherein the data sequence corresponds to a pilot signal or a control signal.

31. The method as recited in claim 30, wherein the comb symbol performs frequency hopping to maintain a predetermined frequency offset including 0 in the step b).

32. The method as recited in claim 31, wherein, in the step a), the top priority order is given to sub-carrier groups including 0 addresses from input addresses of the IFFT unit and output addresses of the FFT unit and the next priority is given to sub-carrier groups neighboring the sub-carrier groups having priority, and comb symbols are allocated to the pilot signal or the control signal according to the priority order.